CHAPTER 34

PAVEMENT DESIGN

34.1 General

Pavement design should be based on the most recent version of the **AASHTO Guide for Design of Pavement Structures and Recommended Reconstruction Pavement Catalog For The District of Columbia**. A cost analysis comparing flexible, rigid and/or composite pavement sections should be used in accordance with the **Life-Cycle Cost Analysis Procedure in Pavement Design For The District of Columbia.**

Special consideration shall be given to recycling of existing pavement materials consistent with the District practice. Consider use of porous asphalt for construction on parking lots and bike trails or potentially parking lanes on residential roadways.

34.1.1 Recommended Minimum Pavement Sections

All new construction and reconstruction of local streets will be constructed with a pavement type as outlined in the pavement selection procedure in this chapter unless directed otherwise or requested by the community. The existing city streets those were constructed with special materials will require a special design consideration in reconstruction of these streets.

Table 34-A:
Minimum Flexible Pavement Section

MINIMUM ASPHALT PAVEMENT SECTION			
Asphalt (In.)	Treated Sub-grade of Base (In.)	Wearing Surface (In.)	Full Depth Asphalt (In.)
5	6	2	7

Table 34-B:
Minimum Portland Concrete Pavement and Composite Sections

PORTLAND CEMENT CONCRETE PAVEMENT		PORTLAND CEMENT CONCRETE BASE WITH ASPHALT OVERLAY (COMPOSITE SECTION)			
PCC Pavement (In.)	Treated Sub-grade of Base (In.)	PCC Base (In.)	Treated Sub-grade of Base (In.)	Leveling Course (In.)	Surface Course (In.)
10	6	10	6	1	1 1/2

For residential, non-federal, (local) streets, 8 in. PCC base for composite section may be considered on a case-by-case basis when approved by the Project Manager.

All PCC pavements shall be reinforced with wire mesh as described in the ***Standard Specifications for Highway Structures 1996*** (Red Book).

34.2 Pavement Selection

The District being the Nation's Capital the preferred practice in selection of pavement is aesthetic and consideration for Stakeholders/Citizens Complaints concerning vibration, noise and appearance.

- The following type pavements are used in the district:
    - Concrete pavement
    - Asphalt pavement
    - Composite pavement
    - Special Pavement (Cobble Stone etc.)
- Over-riding factors in selection of pavement are:
    - Cost
    - Vibration and Noise
    - Aesthetic and Appearance
    - Ride-ability and Vision
    - Maintenance
    - Constructability
    - Traffic Volume

34.3 Engineering Considerations

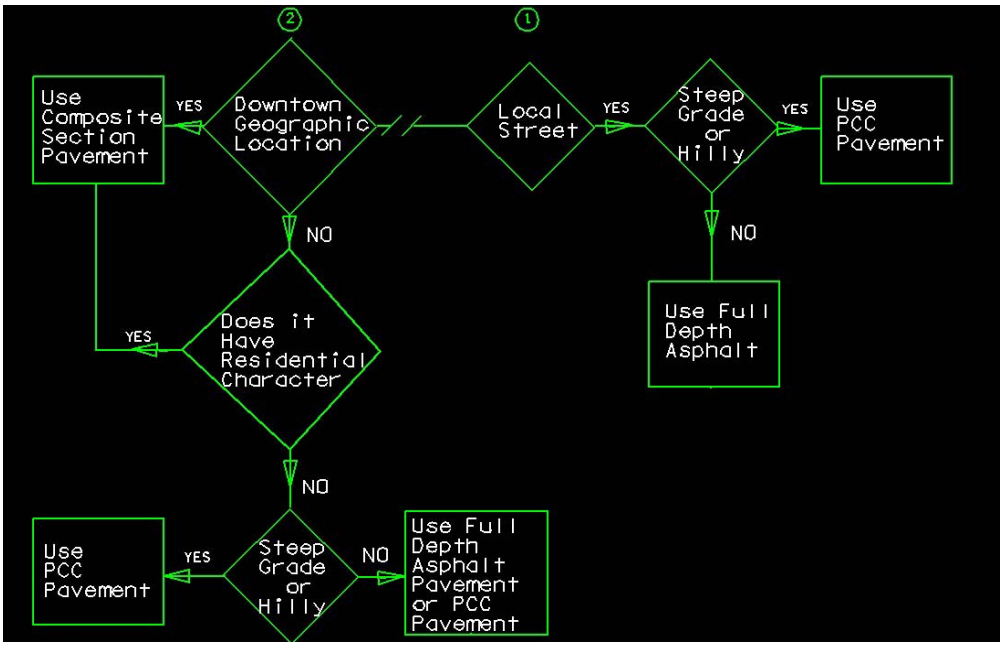
34.3.1 Principal Factors

- Soil Characteristics (Resilient Modulus "R")
- Traffic Volume (ADT value)

34.3.2 Secondary Factors

- Maintenance Cycle
- Availability of Pavement Materials

34.3.3 Pavement Selection Flow Chart



34.3.4 Pavement Design Procedure

34.3.4.1 Design Procedures

The basic design procedure for pavement structures will be that as set forth in the **AASHTO Guide for Design of Pavement Structures**, later version and **Recommended Reconstruction Pavement Catalog For The District of Columbia.**

34.3.5 Rigid Pavement Design

The District policy is to use a slab thickness of 10 in. or greater even if the ESAL levels would suggest that lesser slab thickness would be adequate. A slab thickness of 10 in. or greater provides some assurance of adequate long-term performance given that the other design details are adequately accommodated.

Past performance also suggests that rigid pavement, unlike flexible pavements, can be designed for initial performance periods of 30 to 40 years. This is of significant benefit where rehabilitation and maintenance activities are highly constrained, such as urban roads and streets and all Interstate pavement.

Concrete pavements should be rounded upward to the nearest inch. For example, if the design thickness calculates to be 10.48 inches, the slab thickness will be 11 inches.

34.3.5.1 Shoulders

When PCC shoulders are used they shall have the same PCC slab and base thickness as the mainline roadway. Additionally, the shoulder and mainline roadway PCC shall be tied together with deformed steel bars.

34.3.5.1.1 Edge Course Design

The Aggregate Base for a rigid pavement shall extend 18 in. beyond the pavement edge, or to the outside edge of the porous backfill over the pipe under-drain, or to 6 in. beyond the outside edge of the paved shoulder, whichever is greater. Where curb and gutter or integral curb is used, the aggregate base course shall extend 24 in. beyond the face of the curb or to the outside of the porous backfill over the pipe under-drain, whichever is greater.

34.3.5.1.2 Composite Pavement

Composite pavement herein refers to a rigid base with an asphalt surface. Generally the design of a composite pavement is discouraged due to the relative performance and associated costs. Composite pavements are designed as rigid pavements. The minimum overlay thickness on a rigid pavement or base is 2 ½ in. The concrete base shall extend beyond the wearing surface by 3 in.

34.4 Flexible Pavement Design

Minimum layer thickness, as well as, maximum lift thickness is controlled by requirements contained within DDOT's *Standard Specification*.

Layer thickness and total pavement structure over subgrade soils for flexible pavements are fundamentally based on four criteria:

- Depth to provide a minimum level of serviceability for the design period,
- Depth to prevent excessive rutting,
- Depth to prevent premature fatigue cracking of the AC layers, and
- Depth to provide adequate frost depth protection.

Flexible pavement design is based on the use of the Structural Number. The Structural Number is a regression coefficient expressing the structural strength of a pavement required for given combinations of soil support, traffic loading, and terminal serviceability. Flexible pavements will be constructed with Super-pave mixes; however, regardless of the mix design method used for a flexible pavement, the DDOT/**AASHTO** method of pavement design calculates the same required Structural Number (SN). Another method to use for the design of a flexible pavement is the method described by the **Asphalt Institute** which is also based on the Structural Number.

Once the Structural Number is determined, the flexible buildup is determined by using the appropriate structural coefficient for DDOT specification materials.

34.4.1 Typical Section Design

Regardless of the SN required, a buildup that includes an aggregate base will generally provide better performance than a full depth asphalt concrete buildup. The aggregate base is less sensitive to moisture than the subgrade is and it separates the pavement further from the subgrade. An aggregate base is recommended under all flexible pavements and particularly when the thickness of a full depth flexible design is very thin, approximately 5 in. (SN ~ 1.8) or less. All surface and intermediate courses should be should be specified in 0.25 in. increments. Base Course should be specified in 0.5 in. increments. Aggregate base is typically placed at 6 in. thick. The minimum thickness for Item Aggregate Base is 6 in. and it should be specified in 1 in. increments. When designing a flexible pavement, some consideration should be given to reducing the total number of separate lifts required. This can be done by keeping in mind the maximum and minimum lift thickness for all of the materials involved. Maximum and minimum lift thickness can be found either in the Construction and Materials Specifications.

34.4.2 Edge Course Design

Aggregate Base shall extend 6 in. beyond the edge of the overlying bituminous base for bituminous base courses 9 inches or less in thickness and 12 in. beyond the edge for bituminous base courses thicker than 9 in. Each course, regardless of the number of lifts required by the specifications, shall be designed and shown in a vertical plane. Any base course shall extend beyond the edge of the overlying intermediate course a distance equal to the thickness of the surface course plus the intermediate course or 5 in., whichever is greater. The outside edge of the intermediate course shall be in alignment with the outside edge of the surface course.

34.4.2.1 Shoulders

The minimum requirements for flexible pavement shoulders are:

Interstate
- 7 in. Class B
- Variable Depth Aggregate Base

Non-Interstate
- 5 in. Class B
- Variable Depth Aggregate Base

34.4.2.1.1 Shoulder Buildups

Shoulders are used to provide an area for the accommodation of disabled vehicles, for the lateral support of the base and surface courses, to improve the safety of a highway, and for future maintenance of traffic operations during maintenance and rehabilitation work. Shoulders for flexible pavements shall be constructed of the same materials and thickness as the mainline pavement for all Interstate, freeways, expressways, and other multi-lane facilities. This provides for the ability to have a hot longitudinal joint at the pavement-shoulder interface, provides a stable temporary pavement for maintenance of traffic lane shifts, and reduces the complexity of construction. Using other types of shoulders, such as bituminous surface treated, stabilized aggregate, or turf shoulders must be in accordance with Geometric Standards, Roadway Design. Regardless of shoulder type, shoulder base and subgrade considerations must include the directing of drainage away from the pavement, rather than towards it.

34.4.2.1.2 Paved Shoulder Edge Course Design

Where shoulders are constructed with a buildup different than the mainline pavement, the outside edge of each course shall extend 6 in. beyond the edge of the overlying course.

34.4.3 General Design Considerations

Cross Slope on a pavement is provided to drain water from the street surface. The design of Cross Slope shall consider driver comfort and safety. Undivided traveled ways on tangents, or on flat curves, have a crown or high point in the middle and cross slope downward toward both edges. Unidirectional cross slopes across the entire width of the traveled way may be utilized. The downward cross slope may be a plane or rounded section or a combination.

34.4.3.1 Minimum Cross Slope

A minimum Cross Slope on all new streets shall be 2 percent except as approved by the Engineer. Minimum Cross Slope on reconstruction or overlays of existing roadways shall be 1.0 percent.

34.4.3.2 Maximum Allowable Cross Slope

Maximum allowable Cross Slope on all new construction shall be 3 percent. Maximum allowable Cross Slope on any reconstruction or overlays of existing roadways shall be 4 percent or a maximum of 5 percent on roadways with parking lanes.

34.4.3.3 Cross Slope for Street Modifications

When widening an existing street or adding turn lanes to an existing street, the resulting Cross Slope of the widened portion shall be within the limits stated above and the new Cross Slope shall be no less than the existing Cross Slope.

If the Cross Slope of the existing street exceeds the Standards then curb and gutter shall be designed such that the existing pavement, when overlaid, will result in a straight line Cross Slope grade that meets these Standards. Alternatively, the existing pavement may be removed and re-profiled to comply with these Standards.

Provide criteria when three or more lanes are inclined in the same direction on multilane highways, each successive pair of lanes or portion thereof outward from the first two lanes from the crown line may have an increased slope. The two lanes adjacent to the crown line should be pitched at the normal minimum slope, and on each successive pair of lanes

or portion thereof outward, the rate may be increased by about .5 to 1 percent.

Note: In hilly areas of D.C. where it is sometime impossible to actually meet design standards, exceptions will have to be made. Each situation will be on a case-by-case basis.

34.4.4 Shoulders Width

Shoulder widths may vary between 2 ft. and 12 ft. depending on highway classification and may be surfaced with a variety of materials (as determined by the Program Manager). Shoulder widths shall be a minimum of 10 ft. on freeways and interstate highways.

Shoulders are important links in the lateral drainage systems. Shoulders should be flush with the roadway surface and abut the edge of the thru-lane/auxiliary lane. Shoulder cross slopes should be sloped from 2 to 8 percent depending upon surfacing material used. Shoulder contrast is desirable and may be obtained by using different colors or textures from the traveled way surface or by the use of edge lines as described in the **MUTCD**.

Left shoulders are preferred on all divided highways. The desirable median shoulder width on 4-lane and 6 to 8-lane highways is 5 ft. and 10 ft. respectively. The minimum left shoulder width on highways is 3 ft. and on freeways is 4 ft. In order to provide wider lanes on 3R projects, the left shoulder width on an existing divided multilane highway may be reduced to 1 ft.

For additional sources of information and criteria relative to shoulder design, refer to the **AASHTO Green Book** and the **NCHRP Report 254, Shoulder Geometrics and Use Guidelines.** For additional sources of information and criteria relative to bicycle compatible shoulder design, refer to the **AASHTO Guide for the Development of Bicycle Facilities.**